



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

# The Influence of the COVID-19 Pandemic on Technology: Adoption in Health Care



Bonnie Clipper, DNP, MA, MBA, RN, CENP, FACHE

SARS-CoV-2 (coronavirus disease 2019 [COVID-19]) has affected nearly every aspect of our lives. It has certainly changed how we deliver health care. In part, it has accelerated the development and use of technology solutions in health care. These technology tools were originally identified as mechanisms that would make future care easier or better; however, these tech solutions amidst COVID-19 are now viewed as essential. The use of technology discussed in this article has been accelerated during the current crisis because technology can provide distance, safety for health care professionals and patients, faster results reporting, virtual visits, and more. As we move forward, technology will continue to be positioned to best address public health needs and improve care efficiencies, as well as develop treatments and vaccines. Specifically, this article explores the adoption and growth of technology tools including: telehealth, artificial intelligence, and robotics over the first 90 days of the COVID-19 pandemic in the United States.

Nearly everything in our personal and professional worlds has changed as a result of the coronavirus disease 2019 (COVID-19) pandemic, from how we shop, travel, work, educate students, care for patients, and even how we spend time with those we care about. We continue to hear about how a new normal will be realized as we will go about our lives in a very different way. This is true of technology utilization/adoption in care delivery as well.

An ongoing theme of discussion in current technology communities has been how we have been experiencing more technology adoption over the first half of 2020 than we have in the previous few years. The new concern over minimizing COVID-19 exposure, recent regulatory/reimbursement changes, convenient access, and ease of use have driven this boom in emergent technology use. The 3 subcategories of health care technology experiencing rapid growth during the COVID-19 pandemic are telehealth and virtual care, artificial intelligence, and robotics.

## KEY POINTS

- **Technology adoption is currently occurring faster than ever due to the willingness to adopt solutions to reduce the risk/fear associated with the virus, “temporary” reimbursement and regulatory barrier reductions, and strong outcomes and satisfaction with new care delivery tools.**
- **Understanding technology and how it benefits patient care can be used to mitigate risk and improve safety which will reduce friction points and aid in adoption.**

## EXPANDED USE OF TELEHEALTH AND VIRTUAL CARE

Telehealth is defined as “the use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health and health administration.”<sup>1</sup> In general, telehealth focuses on providing services to patients at a distance and can include monitoring (e.g., wound healing), high risk patient management for patients who find it difficult to visit the provider office (e.g., ALS patient), or quicker chronic disease check-ins (minimizing the amount of office visits). Along similar lines, virtual care refers to “virtual visits that take place between patients

and clinicians via communications technology.”<sup>2</sup> Think of this as basically replacing an in-person visit with a virtual visit. For most people, virtual care is accessible, simple to use, and available 24/7. Virtual care also has a double benefit in that in many cases, it can allow providers to work remotely, as well as the patients who are also remote, thus ensuring low virus exposure risk to both the provider and the patient. However, this is not to gloss over the fact that it does require Internet access and a reliable device, which is an example of the issues that prevent it from being adopted in all communities. The flexibility in access certainly sets it apart from the status quo of rigid office hours with providers, and the convenience of virtual care eliminates the need and expense of driving to an office, parking, waiting to be seen, and then returning home. Virtual visits are also being used for in-patient settings to provide access to specialists who may not be readily available for in-person visits.

On March 13, 2020, in response to the heightened crises from COVID-19, President Trump announced an emergency declaration of the Stafford Act and the National Emergencies Act, allowing the Centers for Medicare & Medicaid Services (CMS) to expand Medicare’s telehealth benefits under the COVID-19 Preparedness and Response Supplemental Appropriations Act.<sup>3</sup> This unique action by CMS relaxed regulatory guidelines and expanded reimbursement and access to telehealth/virtual care to all Americans who have coverage for services under CMS. Prior to this announcement, Medicare reimbursed clinicians for a narrow set of telehealth services and only under certain specific circumstances.<sup>3</sup> After CMS expanded reimbursements for telehealth/virtual care, private insurers quickly followed suit.<sup>3</sup> Clearly, this was a dramatic change that will likely have an immense impact on how care is delivered long into the future.

Telehealth is a critical tool with the following benefits<sup>4</sup>:

- Protects health professionals and patients
- Enables remote work for providers
- Increases access to health care
- Conserves supplies and precious hospital beds
- Supports specialty care (i.e., psychiatry, cardiology, etc.)
- Brings care to populations in need of care

The temporary reimbursement changes coupled with other regulatory remedies such as temporary changes in licensure requirements, granting providers practice authority across state lines, set the perfect environment for a continued boom in telehealth through virtual care. This surge in utilization is expected to continue well into the foreseeable future because CMS has already hinted that some of the changes will become permanent.<sup>5</sup>

Examples of the explosive growth in telehealth/virtual care include:

- Intermountain Health has experienced an increase from 100 visits per month to 50,000 telehealth visits per week after the March 13, 2020, announcement.<sup>6</sup>
- Over the course of a 6-week period, Cleveland Clinic saw a complete shift in how they performed outpatient visits, transitioning from 2% of outpatient visits being conducted through telehealth to 75% being performed via telehealth.<sup>7</sup>
- And another example is MedStar, who increased from 240 telehealth visits in February 2020 to 50,000 telehealth visits from mid-March to mid-April.<sup>8</sup>

People are using telehealth and having virtual care visits more than ever. A survey of 1263 adults in the first week of May 2020 by the Alliance of Community Health Plans and the Academy of Managed Care Pharmacies found that 28% used some type of virtual care over the past 3 months, which is nearly triple the previously documented average.<sup>9</sup> Of those who used telehealth or had a virtual care visit, 89% said they were satisfied with their experience.<sup>9</sup> As more consumers are socialized to virtual care and have positive experiences, it can be anticipated that it will become increasingly accepted as a norm and eventually may become the preferred means of provider interaction when receiving noninterventional care.

## RAPID ADVANCEMENT OF ARTIFICIAL INTELLIGENCE

Although there are multiple definitions for artificial intelligence or augmented intelligence (AI), perhaps the most widely used is “the art of creating machines that perform functions that require intelligence when performed by people.”<sup>10</sup> AI use has been identified as having several benefits, including speed, accuracy, improved cost effectiveness, and in many cases, improved safety. On occasion, AI may prove useful to serve as a human proxy when there are not enough human counterparts to assume a needed, often dangerous, function. Thus, there is the potential for AI to supplement available labor. During the current COVID-19 pandemic, the value of AI became increasingly apparent in interim roles to address safety concerns and the risk of virus exposure.

AI use during the COVID-19 pandemic has focused around 4 areas that include<sup>11</sup>:

- Detection and diagnosis
- Monitoring the effectiveness of treatment
- Contact tracing, modeling of virus spread, and mortality projections
- Treatment and vaccine development

AI can assist in the detection and diagnosis of COVID-19 by quickly analyzing symptoms and identifying “red flags” in metadata and then notifying the proper medical or public health authorities. Artificial intelligence is also being used by several organizations to review radiology films for signs and characteristics of COVID-19. Not only is artificial intelligence faster, it is also a more accurate way to detect and diagnose the disease. Thus, saving time in the identification of COVID-19 and improving patient outcomes.

Artificial intelligence is also being used to monitor the effects of treatments through lab values, radiology reports, or translational electronic health record databases. This allows for faster identification of successful treatments, as well as identification of ineffective treatments, enabling providers to focus their efforts on the treatments that have best outcomes.<sup>11</sup>

AI can be used to analyze the spread of infection by identifying outbreaks as cell phone data, and social media data can predict where the virus will show up in the future and where it is likely to reappear.<sup>11</sup> This same technology can be used to perform individual contact tracing. Not only can the movement of the virus be accurately detected and predicted, so can infection and mortality rates, which allow authorities to plan, react, and communicate accordingly. AI-driven models have been used by public health officials around the world to inform their recommendations during the COVID-19 pandemic.

Artificial intelligence is also being used to speed the time of therapeutics and vaccine development by analyzing metadata and searching for therapeutics that will have an impact on the RNA-specific sequence and proteins of COVID-19.<sup>12</sup> The clear benefit of artificial intelligence in this function is time.

## ROBOTS FIND A PLACE

Although we have seen a slow growth trajectory in the utilization of robots in health care over the past few years, the COVID-19 pandemic has jet fueled the adoption of robots. It's no secret that service robots have been quietly and slowly arriving on the scene to supplement members of the care team by focusing on tasks such as delivering medications and supplies to patient care areas, thus freeing up caregivers to focus on the important activities that require human interaction, critical thinking, and empathy.<sup>13</sup> The gradual adoption of robots in health care as a way to improve efficiency has followed a slow adoption curve, often due to costs and concerns over potential job eliminations. The services by robots are predictably consistent, eliminating the variation that comes with human interaction, and their use allows personnel to be deployed to the highest priority area necessary.

Fast-forward to the COVID-19 pandemic. As COVID-19 surged in China's Hubei province, hospitals were quickly overwhelmed, and 2 hospitals were

rapidly constructed for the purpose of providing care for COVID-19 patients. At the same time, an ongoing concern was the number of health care workers that were becoming infected with COVID-19. As an experiment, a small army of 14 humanoid-looking robots were introduced into the COVID units to assist physicians and nurses.<sup>14</sup> The robots had specific roles such as communicating with patients, taking temperatures, and even making beds. These robots are sophisticated and anthropomorphic, meaning that they resemble humans, but not too closely.<sup>14</sup> These robots are able to speak and understand general concepts, they can move in smooth, fluid, human-like ways, and have a low “creep out” factor.

The reason for this design was to create a low barrier of resistance for these robots so they could assist in patient care. In crisis mode, the robots were accepted, even welcomed, for the help that they provided. This was predominantly because the robots performed tasks that allowed humans to “stay safe” and minimize their risk to virus exposure. In the midst of the pandemic, the robots got right to work. The chaos and frenzy decreased the barrier to entry for this army of robots. It is highly likely that because these robots have been successfully deployed to assist in COVID units, they will receive a warm welcome in other units and will be integrated into workflows with much less objection than usual. It is unknown at this time as to whether these are in use in the United States.

The COVID-19 pandemic also saw an increase in the use of room cleaning and UV light robots, which have been on the health care scene for several years now. These robots have been around for nearly 10 years and have been proven to destroy *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus*, and other pathogens, including COVID-19, and are extremely helpful as a means to disinfect hospital rooms and are safer for their human counterparts, the environmental services staff.<sup>15</sup> At only 15 minutes per room to provide a 99.99% disinfection rate, the efficiency, safety, and efficacy in which these robots work has created 400% to 600% growth in orders. These special room-cleaning robots use short-wavelength ultraviolet C to destroy the DNA and RNA strands of the virus, thus rendering the virus neutralized.<sup>16</sup> There are several versions of UV robots being deployed in hospitals, where they are becoming a more common mainstay in the environmental services and infection prevention ecosystem. As a result of the pandemic, cleaning and UV light robots are also being used at grocery stores and schools. The growth in utilization of robots for this purpose is projected to continue as we adjust to living with COVID-19.

## THE NEW TECHNOLOGY “NORMAL”

The holes in the proverbial Swiss cheese have lined up perfectly, and there are a handful of conditions that

have fueled the adoption and utilization of technology during the current COVID-19 pandemic. Although some technology adoption leaps seem extraordinary, it is unlikely that we will backslide all the way back to where we started February 2020 in the areas of telehealth and virtual care, artificial intelligence, and the use of robots in health care. Even though it has only been months, it is hard to recall life before the COVID-19 pandemic. This is true, not only in our personal lives, but also in our use of technology in health care. Although the human impact of the COVID-19 pandemic has been devastating, it has also enhanced the need and ability to incorporate technology solutions at a pace never seen before. As CMS Administrator Seema Verma says, “the [technology] genie won’t go back in the bottle.”<sup>5</sup> Thus, our (nursing) efforts should now pivot to defining the new normal and educating health care providers and patients alike. Integration of the new and emerging technologies is critical to optimize this vision.

## REFERENCES

1. HealthIT.gov. What Is Telehealth? How Is Telehealth Different From Telemedicine? Last reviewed October 17, 2019. Available at: <https://www.healthit.gov/faq/what-telehealth-how-telehealth-different-telemedicine>. Accessed June 2, 2020.
2. Care Innovations. What Is Virtual Care, and How Does It Fit Into Telehealth? 2020. Available at: <https://news.careinnovations.com/blog/what-is-virtual-healthcare-how-does-it-fit-into-telehealth>. Accessed June 2, 2020.
3. Centers for Medicare & Medicaid Services. President Trump Expands Telehealth Benefits for Medicare Beneficiaries During COVID-19 Outbreak. March 17, 2020. Available at: [www.cms.gov/newsroom/press-releases/president-trump-expands-telehealth-benefits-medicare-beneficiaries-during-covid-19-outbreak](http://www.cms.gov/newsroom/press-releases/president-trump-expands-telehealth-benefits-medicare-beneficiaries-during-covid-19-outbreak). Accessed April 30, 2020.
4. Guillot C. 6 Reasons Telehealth Is Now More Important Than Ever. Health Tech Magazine; May 14, 2020. Available at: <https://healthtechmagazine.net/article/2020/05/6-reasons-telehealth-now-more-important-ever>. Accessed June 2, 2020.
5. Dyrda L. 'The Genie's Out of the Bottle on This One': Seema Verma Hints at the Future of Telehealth for CMS Beneficiaries. Becker's Hospital Review; April 28, 2020. Available at: <https://www.beckershospitalreview.com/telehealth/the-genie-s-out-of-the-bottle-on-this-one-seema-verma-hints-at-the-future-of-telehealth-for-cms-beneficiaries.html>. Accessed June 4, 2020.
6. Landi H. Payers Have Lowered Barriers to Telehealth. Will Those Changes Stick? Here's What Experts Have to Say. Fierce Healthcare; 2020. Available at: <https://www.fiercehealthcare.com/practices/trump-administration-has-lowered-barriers-to-telehealth-will-those-changes-stick-here-s>. Accessed May 4, 2020.
7. Consult QD. Cleveland Clinic's Digital Health Playbook: Telehealth Materials for Rapid Adoption and Scaling in a Pandemic. Cleveland Clinic; April 17, 2020. Available at: <https://consultqd.clevelandclinic.org/cleveland-clinics-digital-health-playbook/>. Accessed May 4, 2020.
8. Levanthal R. From Hundreds of Telehealth Visits to 100k: Behind MedStar's Virtual Care Surge. Healthcare Innovation; May 21, 2020. Available at: <https://www.hcinnovationgroup.com/population-health-management/telehealth/article/21139273/from-hundreds-of-telehealth-visits-to-100k-behind-medstars-virtual-care-surge>. Accessed June 2, 2020.
9. King R. Survey: 72% of Consumers Have Changed Healthcare Use Since COVID-19 Pandemic. Fierce Healthcare; May 21, 2020. Available at: <https://www.fiercehealthcare.com/hospitals-health-systems/survey-72-consumers-have-changed-healthcare-use-since-covid-19-pandemic>. Accessed June 2, 2020.
10. Kurzweil R. *The Age of Intelligent Machines*. Cambridge, MA: MIT Press; 1990.
11. Vaishya R, Javaid M, Khan IH, Haleem A. Artificial Intelligence (AI) applications for COVID-19 pandemic. *Diabetes Metab Syndr*. 2020;14(4):337-339.
12. Grossman G. *The Role of AI in the Race for a COVID-19 Vaccine*. InformationWeek; March 12, 2020. Available at: <https://www.informationweek.com/big-data/ai-machine-learning/the-role-of-ai-in-the-race-for-a-covid-19-vaccine/a-d-id/1337278>. Accessed April 30, 2020.
13. Clipper B, Batcheller J, Thomaz AL, Rozga A. Artificial intelligence and robotics: a nurse leader's primer. *Nurse Leader*. 2019;16(6):379-384.
14. Smith L. How Robots Helped Protect Doctors From COVID-19. Fast Company; March 26, 2020. Available at: <https://www.fastcompany.com/90476758/how-robots-helped-protect-doctors-from-covid-19>. Accessed April 29, 2020.
15. Azevedo MA. Hospital-Disinfecting Robots: Xenex Sees Surge in Orders as COVID-19 Pandemic Escalates. Crunchbase News; March 25, 2020. Available at: <https://news.crunchbase.com/news/hospital-disinfecting-robots-xenex-sees-surge-in-orders-as-covid-19-pandemic-escalates/>. Accessed April 29, 2020.
16. Ackerman E. Autonomous Robots Are Helping Kill Coronavirus in Hospitals. IEEE Spectrum; March 11, 2020. Available at: <https://spectrum.ieee.org/automaton/robotics/medical-robots/autonomous-robots-are-helping-kill-covid-19-in-hospitals>. Accessed May 1, 2020.

Bonnie Clipper, DNP, MA, MBA, RN, CENP, FACHE, is chief clinical officer at Wambi and chief catalyst at Innovation Advantage in Austin, Texas. She can be reached at [bonnie.clipper@wambi.org](mailto:bonnie.clipper@wambi.org).

Note: No funding has been provided for this work: This work did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

1541-4612/2020/\$ See front matter  
Copyright 2020 by Elsevier Inc.  
All rights reserved.  
<https://doi.org/10.1016/j.mnl.2020.06.008>